SYSTEM AND PROCESS FOR DETECTING A LOAD OF CLOTHES IN AN AUTOMATIC LAUNDRY MACHINE

Field of the Invention

The present invention refers to a system to be applied to automatic laundry machines, which allows detecting a load of clothes put into the laundry machine and automatically selecting the level of the washing liquid to be supplied to the machine according to the washing program selected by the user.

The invention further relates to a process for detecting a load of clothes put into the laundry machine and for automatically selecting the level of the washing liquid to be supplied to the machine, as a function of the detected load of clothes.

Prior Art

There are known different systems for detecting a load of clothes put into a laundry machine and thus defining and controlling, automatically, the amount of the washing liquid, generally water, to be supplied to the machine, more precisely to the tub inside which is seated a basket designed to contain the load of clothes and which is rotatively driven, upon the spin operation, by an electric motor which also drives an agitator provided in the interior of the basket.

One of such known detecting systems is described in Patent US 5,515,565, which uses a height sensing means to detect the height of the load of clothes placed into the basket. An electronic control unit, which is operatively associated with the height sensing means of the load of clothes, processes the signal coming from the height sensing means and which is representative of the height of the load of clothes, so as to determine the adequate level of the washing liquid to be admitted into the tub and to control the operation of a washing liquid inlet device, in order

to maintain the latter opened, until a level sensing means detects the obtainment of the washing liquid level determined by the control unit.

In a preferred form, the height sensing means comprises means for transmitting and receiving sonic pulses that act on the load of clothes within the basket under rotation. While adequately operating, this prior art system requires complex expensive means and constructions.

Another known system is disclosed in Patent US 6,460,381. In this solution, a pressure sensor is provided, mounted jointly with the suspension of the tub and which is constructed so as to have its magnetic characteristics altered as a function of the stresses to which it is subjected. The variations of the magnetic characteristics are converted in inductance variations in a coil, generating oscillating signals whose frequency varies as a function of the inductance, allowing detecting the load on the sensor. Thus, the load of clothes placed in the basket can be determined, as well as the load of the washing liquid to be subsequently supplied to the tub of the machine, and the clothes-washing liquid total load is converted into a corresponding adequate level of the washing liquid. Upon reaching the desired level, the supply of the washing liquid is automatically interrupted by actuation of an electronic control unit.

This type of prior art system may present mechanical errors produced during manufacture or have the weight sensor located in an inadequate position, impairing the accuracy in detecting the weight of both the clothes and the washing liquid, resulting in washing operations presenting an amount of water out of the desirable standards.

Still another known prior art system is described in Patent US 4,862,710. This prior system uses a load detecting means in the motor to detect an electrical value representative of a rise characteristic of the motor, which varies in accordance with a load acting on a motor which drives the movable washing means of the machine. During the spin cycle of the machine, the time in which the value detected by the load detector reaches a second reference value is measured, from a first reference value.

The time measured is converted in the value of the clothes-washing liquid total load inside the tub of the machine. In this solution, the first and the second reference values are voltage values measured in the load detector, and the time the motor takes in the spin cycle, to provoke a rise in the voltage and reference values, is associated with a certain level of load of clothes within the basket.

This prior art solution uses the voltage rise time between two reference values, which are corrected as a function of the supply voltage, to determine the load of clothes in the basket and the corresponding operational parameters of the machine in the subsequent operations.

While allowing a certain accuracy in detecting the load of clothes, this prior art solution presents the inconvenience of requiring relatively complex electronic circuits and of not considering the load represented by the friction of the movable parts of the machine, which load varies as a function of the tolerances and of the manufacture and assembly methods of the different components.

Besides the inconveniences above, the prior art solution cited above is subjected to measurement deviations due to the noises produced in the power

source as a function of the voltage variations, which can be intense and frequent. This prior art system does not present a satisfactory accuracy in terms of detecting the load of clothes, particularly when the machine is installed in electric power sources that are subjected to high noise levels.

Objects of the Invention

By reason of the inconveniences and deficiencies of the prior art system for detecting the load of clothes, it is an object of the present invention to provide a system for detecting a load of clothes in an automatic laundry machine, which presents a simple construction of relatively low cost, and high accuracy in detecting the load of clothes placed inside the basket of the machine.

It is a further object of the present invention to provide a system for detecting a load of clothes as mentioned above, which allows determining, automatically, the level of the washing liquid to be supplied to the tub of the machine as a function of the detected load of clothes.

It is still a further object of the present invention to provide a process for detecting a load of clothes in an automatic machine, which permits obtaining, accurately, through simple means of relatively low cost, a signal representative of a load of clothes put into the basket of the machine and which determines the level of the washing liquid to be supplied to the machine.

Disclosure of the Invention

The system for detecting a load of clothes of the present invention is designed to be applied to an automatic laundry machine of the type which comprises a tub, a basket mounted in the interior of the tub and which is dimensioned to receive a load of clothes to

be washed, and an electric motor, which rotatively drives the basket in a spin cycle to be executed by the machine.

According to the invention, the present system comprises a voltage sensor to detect the value of the voltage supplied to the electric motor; a rotation sensor, operatively associated with the electric motor to detect the rotation of the latter; and a control unit, operatively associated with a timer, with the voltage sensor, and with the rotation sensor, and which is supplied, in a presetting step of the machine, with data representative of the medium torque of the electric motor in different voltage ranges, and with data representative of the acceleration and deceleration reference times of the electric motor with the basket in the unloaded condition, between two distinct and predetermined rotation values of the electric motor, in order to calculate the reference moment of inertia of the unloaded basket, said control unit receiving, selectively, at the beginning of each operation of the machine, data representative of the acceleration and deceleration operation times of the electric motor, with the basket containing a load of clothes, between said rotation values of the electric motor, and processing the data representative of the medium torque of the electric motor in the voltage range detected by the voltage sensor, and the data of the reference and operation times, in order to determine the moment of inertia of the basket with the load of clothes and the difference of said moments of inertia of the basket, and to produce a signal representative of the mass of the load of clothes.

The system mentioned above allows, through the provision of the voltage and rotation sensors and by providing the control unit with a timer, establishing

reference data adjusted for each machine in the manufacturing phase, and operational data related to each load of clothes put into the basket, the processing of said data allowing comparing the respective moments of inertia and thence produce a signal which represents, with high accuracy, the load of clothes inserted in the basket and which will be washed, independently of the voltage variations of the power source of the electric motor.

In a particular application of the invention, the signal representative of the load of clothes is associated with a washing liquid level which, when reached, makes the control unit produce a blocking signal to an inlet valve means, interrupting the supply of the washing liquid to the machine.

The invention further relates to a process for detecting the load of clothes in an automatic laundry machine of the type defined above, comprising the following steps:

- rotatively driving the electric motor with the basket unloaded, maintaining its energization until a maximum rotation has been reached, the electric motor being then de-energized and decelerated to a reduced rotation value, as a function of the friction between the movable parts;
- detecting the rotation of the electric motor in two distinct and predetermined rotation values, which are lower than the maximum rotation value, both in the acceleration phase and the deceleration phase;
- measuring the acceleration and deceleration reference times of the electric motor between said distinct and predetermined rotation values;
- calculating a reference moment of inertia of the unloaded basket, in a step of presetting the machine to a posterior operation, by processing, in a control

unit, the data representative of the acceleration and deceleration reference times and of the known medium torque of the electric motor for the determined voltage;

- before each washing operation of the machine, measuring the voltage supplied to the electric motor and rotatively driving the electric motor with the basket containing a load of clothes, maintaining the energization of the electric motor until said maximum rotation has been reached, and de-energizing and decelerating the electric motor by action of the friction between the movable parts;
- detecting the rotation of said electric motor in the two distinct and predetermined rotation values in the acceleration and deceleration phases with a load of clothes;
- measuring the acceleration and deceleration operation times of the electric motor between said distinct and predetermined rotation values;
- calculating the moment of inertia of the basket with the load of clothes, by processing the data representative of the acceleration and deceleration operation times and of the torque of the electric motor for the detected supply voltage;
- calculating the difference between said moments of inertia of the basket and producing a signal representative of the mass of the load of clothes.

In a particular application of the invention, the process may further include an additional step of associating the signal representative of the mass of load of clothes with an adequate washing liquid level in the interior of the basket, in order to interrupt the supply of liquid to said machine after said level has been reached.

Upon reaching the washing liquid level calculated as a

function of the detected mass of the load of clothes, the control unit instructs an inlet valve means to interrupt the supply of the washing liquid.

Brief Description of the Drawings

The invention will be described below, with reference to the attached drawings, given by way of example and in which:

Figure 1 is block diagram of the system of the present invention associated with an automatic laundry machine;

Figure 2 is a graph with the curves showing the variation of rotation of the electric motor for obtaining the reference and operation times during acceleration and deceleration.

Detailed Description of the Invention

As mentioned above and illustrated in figure 1 of the drawings, the present system for detecting a load of clothes is applied to an automatic laundry machine of the type which comprises a structural casing 1, generally defined by a prismatic cabinet, within which is mounted, through suspension means, not illustrated and which may present any adequate construction belonging or not to the state of the art; a tub 2, generally cylindrical and within which is coaxially rotatively mounted a basket 3, generally in the form of a cylindrical drum, having perforated lateral and bottom walls and which is superiorly open and dimensioned to contain a load of clothed to be washed.

In the laundry machines with a vertical shaft, such as that illustrated, the basket 3 has its bottom wall 3a centrally affixed to a tubular shaft 4 projecting vertically downwardly and outwardly from the tub 2, so as to be supported by bearings 5 mounted on a bearing support 6 secured to the bottom wall 2a of the tub 2. This assembly allows the basket 3 to rotate freely

around its axis, in the interior of the tub 2 and seated on the tubular axis 4.

To the tubular shaft 4 there is rotatively supported, generally through bushings 7, a central shaft 8 to whose upper end is secured an agitator 9 positioned on the bottom wall 3a of the tub 3.

The lower end of the central shaft 8 projects outwardly from the tubular shaft 4, in order to receive a driven pulley 13 which is operatively coupled, through a belt 12, to a drive pulley 11 secured to the shaft of an electric motor 10 mounted to the structural casing 1 of the machine, usually being directly or indirectly attached to the bottom wall 2a of the tub 2.

Although not illustrated in figure 1, it should be understood that the laundry machine generally further comprises a locking device to lock the tubular shaft 4 in relation to the structural casing 1 during the wash cycles to be performed by the machine, when only the agitator 9 is impelled by the electric motor 10 in opposite directions, to effect the movement of the load of clothes immersed in the washing liquid inside the basket 3.

It should be further understood that the automatic laundry machine might present different constructions, as long as it is provided with a basket provided in a tub and which is selectively rotatively driven by an electric motor.

In order to command automatically the operations of the machine, there is provided a control unit 20 for the electronic processing of data and which is operatively associated with a voltage sensor 30, a rotation sensor 40, a level meter 50, and an inlet valve means 60 to control the admission of the washing liquid, generally water, to the interior of the basket

3.

The voltage sensor 30 is usually defined by a voltmeter mounted in the machine to detect the value of the voltage supplied to the electric motor 10 an to send to the control unit 20 signals representative of the detected voltage values. The provision of the voltage sensor 30 allows the control unit 20 to consider the voltage value of the power source of the electric motor 10 in any processing operation to be performed thereby.

The rotation sensor 40 takes the form of a tachometer that is operatively associated with the electric motor 10 to supply the control unit 20 with signals to be converted in data representative of the rotation of the electric motor 10.

In a particular way of carrying out the invention, a level sensor 50 is provided, usually in the form of a pressure switch that sends, to the control unit 20, signals representative of different, generally three, levels of the washing liquid to fill the basket 3.

In this construction, whenever the washing liquid reaches any of the levels predetermined by the washing program, the level meter 50 sends a respective signal to the control unit 20, which processes this signal and sends a signal to the inlet valve means 60, closing the latter and interrupting the supply of the washing liquid to the machine.

The inlet valve means 60 can take the form of an electrovalve, for example, whose energization is commanded by the control unit 20.

The control unit 20 is constructed to process the signals received from the different components operatively associated therewith, in order to produce a signal representative of the load of clothes inserted in the basket 3.

The control unit 20 is supplied, in a presetting phase of the machine, with data representative of the medium torque of the electric motor 10 in different voltage values of the power source, generally in different voltage ranges of about 5V.

Thus, the control unit 20 is able to process the voltage signal received from the voltage sensor 30 and to determine the value of the medium torque of the electric motor 10 for the detected voltage of the power source.

According to the invention, in the presetting phase of the machine, which generally occurs during manufacture, the basket 3 is rotatively driven upon the energization of the electric motor 10, from a rest condition, accelerating until reaching a predetermined rotation of the electric motor of about 1.300 rpm, the latter being de-energized so as to decelerate, jointly with the basket, to reduced rotation values, including the rest zero value.

During the acceleration and deceleration of the basket, the control unit 20 detects, by means of the rotation sensor 40, the instants in which the rotation of the shaft of the electric motor 10 reaches two distinct and predetermined rotation values, both in the acceleration and in the deceleration phases of the basket 3. These distinct and predetermined rotation values of the electric motor 10 can be, for example of about 660rpm and 1120rpm, with a difference of about 460rpm between said values.

Besides detecting said rotation values of the electric motor 10, the control unit 20 receives, through a timer 21 incorporated thereto, data representative of the acceleration reference time Ta1 and deceleration reference time Td1 of the electric motor 10 between said distinct and predetermined rotation values.

Once obtained the data representative of the acceleration and deceleration reference times Ta1 and Td1, with the basket in the unloaded condition and the electric motor 10 being energized at a determined voltage, the control unit 20 determines the medium torque Mmot of the electric motor for that voltage value and then calculates the moment of inertia Jv in the unloaded condition of the basket 3, establishing initially zero value for the resistive torque Mres (friction torque) of the rotary assembly, using the following equations:

$$(1)\quad Ta1 = \frac{2\pi\,\Delta rpm}{60} \times \frac{Jv}{Mmot - Mres}$$

$$(2)\quad Td1 = \frac{2\pi\,\Delta rpm}{60} \times \frac{Jv}{Mres}$$

Where:

Mmot = Medium torque of the electric motor

Mres = Resistive torque (friction torque)

Jv = Reference moment of inertia with the basket unloaded

Jc = Moment of inertia of the basket with a load of clothes

Considering the resistive moment Mres as being initially zero in the equation (1), the control unit 20 processes the already received data, in order to calculate a first value for the moment of inertia Jv of the basket 3 in the unloaded condition. With the initial value of the moment of inertia Jv in the unloaded condition, the control unit 20 calculates the resistive moment Mres by means of the formula (2) and subsequently utilizes said value to recalculate the moment of inertia Jv in the unloaded condition by the formula (1), repeating this procedure until the difference between the Jv values reach a determined value close to or equal to zero. The value of the

moment of inertia Jv in the unloaded condition for each manufactured machine is then recorded as the set up of each machine in the respective control unit 20.

Still according to the present system, before each washing operation of the machine, the control unit 20 records, by means of the voltage sensor 30, the voltage supplied to the electric motor 10, so as to select the respective value of the medium torque Mmot, and energizes the motor, in order to accelerate it jointly with the basket 3 already containing the load of clothes to be detected, until the predetermined maximum rotation has been reached, passing by said distinct and predetermined rotation values under acceleration and then, after the de-energization of the motor, under deceleration, allowing the control unit 20 to record the data representative of the acceleration and deceleration times Ta2 and Td2 during operation with the load of clothes.

With the data representative of the medium torque Mmot and of the acceleration and deceleration times Ta2 and Td2 with the load of clothes, the control unit 20 calculates the moment of inertia Jc of the basket 3 containing the load of clothes to be detected, by using the same procedure described in relation to the determination of the moment of inertia Jv of the empty, i.e. unloaded, basket 3.

Once determined the moment of inertia Jc of the basket 3 with the load of clothes, the control unit 20 begins to calculate the load of clothes by the difference between the moments of inertia Jc in the loaded condition and the moment of inertia Jv in the unloaded condition, producing a respective signal to be used in a subsequent operation of the machine to be performed with at least one parameter depending on the value of the load of clothes placed in the basket 3.

In a particular form of applying the present system, the control unit 20 associates the data representative of the load of clothes with a determined level of the washing liquid inside the basket 3. When this level, which is determined as adequate by the control unit 20, is detected by the level meter 50, the control unit 20 instructs the closing of the inlet valve means 60, interrupting the supply of the washing liquid to the machine.

The subsequent operations may vary as a function of the operation programs associated with the control unit and which are generally selected by the user.